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Inventor(s):

Address: Block 14 Marine Terrace #15-180 Singapore 440014  
THE REPUBLIC OF SINGAPORE

Name: William Brent Wilson

Applicant(s):

Identification No.: 000005821  
Address: 1006, Oaza Kadoma, Kadoma-shi, Osaka-fu, Japan  
Name: Matsushita Electric Industrial Co., Ltd.

Patent Attorney:

Identification No.: 100062144  
Name: Tamotsu AOYAMA

Appointed Patent Attorney:

Identification No.: 100086405  
Name: Osamu KAWAMIYA

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[Document name] Specification

[Title of the invention] Method and Apparatus For Reducing Processing  
Power Requirements of a Video Decoder

[The claims]

5 [Claim 1] An apparatus for reducing processing power requirements of a  
video decoder comprising:

controlling means for controlling said processing power requirements  
of said decoder by using a predetermined throttling amount.

10 [Claim 2] An apparatus according to claim 1, wherein determination of  
said determined throttling amount comprises the use of one or more of the  
following:

one or more measures of the processing power required to decode  
one or more bitstreams; and

one or more measures of said decoder's processing capabilities.

15 [Claim 3] An apparatus according to claim 2, wherein said measures of  
the processing power required to decode a bitstream comprises of one or  
more of the following:

an indication of the syntax elements in said bitstream;

an indication of the type of processing required for said bitstream;

20 an indication of the amount of processing required for said bitstream;

a combination of the type and amount of processing required for said  
bitstream.

[Claim 4] An apparatus according to claim 1, 2 or 3, wherein said  
controlling means for controlling said processing requirements comprises:

25 means for reducing the processing power used for one or more  
decoder functions by limiting said decoder function in some way.

[Claim 5] An apparatus according to claim 4, wherein said means for

limiting said decoder function comprises:

means for turning off the use of one or more of the motion vectors normally used to retrieve a motion compensated reference.

[Claim 6] An apparatus according to claim 4, wherein said means for

5 limiting said decoder function comprises:

means for selecting from a choice of motion vectors which refer to different reference pictures, one or more motion vectors to turn off;

means for turning off the use of selected motion vectors normally used to retrieve a motion compensated reference.

10 [Claim 7] An apparatus according to claim 6, wherein said means for selecting motion vectors comprises the following:

means for selecting the motion vectors which are of the longest distance.

[Claim 8] An apparatus according to claim 6, wherein said means for

15 selecting motion vectors comprises the following:

means for selecting the motion vectors which are least highly correlated with those motion vectors in surrounding regions of the picture region being decoded.

[Claim 9] An apparatus according to claim 6, wherein said means for

20 selecting motion vectors comprises the following:

means for selecting the motion vectors which are of spatially longest distance.

[Claim 10] An apparatus according to claim 6, wherein said means for selecting motion vectors comprises the following:

25 means for selecting all motion vectors.

[Claim 11] An apparatus according to claim 4, wherein said means for limiting said decoder function comprises:

means for modifying the value of one or more of the decoder's motion vectors.

[Claim 12] An apparatus according to claim 11, wherein said means for modifying the value comprises:

5 means for limiting the precision of one or more of the decoder's motion vectors.

[Claim 13] An apparatus according to claim 11, wherein said means for modifying the value comprises:

10 means for limiting the range of one or more of the decoder's motion vectors.

[Claim 14] An apparatus according to claim 4, wherein said means for limiting said decoder function comprises:

15 means for reducing the number of coefficients inverse quantized and inverse DCT transformed by selectively setting coefficients to alternate values.

[Claim 15] An apparatus according to claim 14, wherein said alternate values comprises:

zero.

20 [Claim 16] An apparatus according to claim 4, wherein said means for limiting said decoder function comprises:

means for eliminating the decoder processing of one or more of the color components.

[Claim 17] An apparatus according to claim 4, wherein said means for limiting said decoder function comprises:

25 means for reducing the amount of processing performed on decoded pictures preceding their display.

[Claim 18] A method of reducing processing power requirements of a video

decoder comprising:

controlling said processing power requirements of said decoder by using a predetermined throttling amount.

[Claim 19] A method according to claim 18, wherein determination of said  
5 determined throttling amount comprises the use of one or more of the following:

one or more measures of the processing power required to decode one or more bitstreams; and

one or more measures of said decoder's processing capabilities.

10 [Claim 20] A method according to claim 19, wherein said measures of the processing power required to decode a bitstream comprises of one or more of the following:

an indication of the syntax elements in said bitstream;

an indication of the type of processing required for said bitstream;

15 an indication of the amount of processing required for said bitstream;

a combination of the type and amount of processing required for said bitstream.

[Claim 21] A method according to claim 18, 19 or 20, wherein said controlling said processing requirements comprises:

20 reducing the processing power used for one or more decoder functions by limiting said decoder function in some way.

[Claim 22] A method according to claim 21, wherein said limiting said decoder function comprises:

25 turning off the use of one or more of the motion vectors normally used to retrieve a motion compensated reference.

[Claim 23] A method according to claim 21, wherein said limiting said decoder function comprises:

selecting from a choice of motion vectors which refer to different reference pictures, one or more motion vectors to turn off;

turning off the use of selected motion vectors normally used to retrieve a motion compensated reference.

5 [Claim 24] A method according to claim 23, wherein said selecting motion vectors comprises the following:

selecting the motion vectors which are of the longest distance.

[Claim 25] A method according to claim 23, wherein said selecting motion vectors comprises the following:

10 selecting the motion vectors which are least highly correlated with those motion vectors in surrounding regions of the picture region being decoded.

[Claim 26] A method according to claim 23, wherein said selecting motion vectors comprises the following:

15 selecting the motion vectors which are of spatially longest distance.

[Claim 27] A method according to claim 23, wherein said selecting motion vectors comprises the following:

selecting all motion vectors.

[Claim 28] A method according to claim 21, wherein said limiting said  
20 decoder function comprises:

modifying the value of one or more of the decoder's motion vectors.

[Claim 29] A method according to claim 28, wherein said modifying the value comprises:

limiting the precision of one or more of the decoder's motion vectors.

25 [Claim 30] A method according to claim 28, wherein said modifying the value comprises:

limiting the range of one or more of the decoder's motion vectors.



[Claim 31] A method according to claim 21, wherein said limiting said decoder function comprises:

reducing the number of coefficients inverse quantized and inverse DCT transformed by selectively setting coefficients to alternate values.

5 [Claim 32] A method according to claim 31, wherein said alternate values comprises:

zero.

[Claim 33] A method according to claim 21, wherein said limiting said decoder function comprises:

10 eliminating the decoder processing of one or more of the color components.

[Claim 34] A method according to claim 21, wherein said limiting said decoder function comprises:

15 reducing the amount of processing performed on decoded pictures preceding their display.

[Detailed description of the invention]

[0001]

[Application field in industry]

20 This invention relates to the field of digital video decoders and the reduction of computational requirements of these decoders.

[0002]

[Prior art]

25 Digital video has become widespread in the field of consumer electronics, due in large part to the emergence of digital video standards such as MPEG1 (see "CD11172 - Coding of Moving Pictures and Associated Audio for Digital Storage Media at up to about 1.5 Mbps" by International Organisation for Standardisation, ISO MPEG Document, ISO-

IEC/JTC1/SC2/WG11, 1994), MPEG2 (see "IS13818 - Generic coding of Moving Pictures and Associated Audio" by International Organisation for Standardisation, ISO MPEG Document, ISO-IEC/JTC1/SC2/WG11, 1994), and the emerging standard MPEG4, which includes further added  
5 functionality and quality over MPEG1 and MPEG2.

[0003]

In MPEG1 and MPEG2 decoders, there are certain expectations regarding the decoder computational power which must be met in order to conform to the respective standard. For example, in the MPEG2 standard,  
10 Main Profile and Main Level (MP@ML) describes a set of bounds on the bitstream and associated video which all conformant MP@ML decoders must adhere to.

[0004]

There are many situations where a decoder lacks sufficient  
15 computational power to decode a bitstream as it was intended. One example is on the internet where typically MPEG1 video bitstreams can be found and decoded using computers varying from high end scientific work stations to simple personal computers. When computational power is limited, one way the decoder can reduce it's computational requirements is to  
20 simply slow down the decoder output picture rate enough to permit all decoding to be accomplished. This was a very common method used by software based MPEG1 video decoders running on personal computers. Another method is to periodically skip the decoding of some pictures. For example, bi-directionally predicted pictures (B-pictures) can be skipped,  
25 effectively reducing the decoder output picture rate by picture-dropping.

[0005]

MPEG4 includes the concept of video objects, which are picture

sequences which may be used to describe a separable object in a scene. If a scene contains many objects, the least important objects can be dropped in favour of giving the necessary computational power to the decoding of the more important objects.

5 [0006]

[Problem to be solved by the invention]

There is a growing abundance of digital video bitstreams available, and a growing number of computational requirements associated with each.

Due to the wide range of platforms that can be used for video decoding,  
10 there is a need for decoders which can decode bitstreams without requiring the full computational power required to meet conformance criteria.

Existing techniques such as picture display rate reduction, picture dropping or object dropping techniques reduce the computational power at the expense of decoded video picture quality and synchronisation. For example,  
15 changing the picture display rate and picture dropping can have an effect on the perceived synchronisation of audio and video, commonly referred to as lip-synch. It also has the effect of making scenes with motion appear jerky.

[0007]

An object of this invention is to permit video decoders to reduce the  
20 computational requirements of decoding a bitstream without affecting the picture rate. This will permit lip-synch to be maintained while compromising visual quality. It will also permit scenes which become jerky using picture dropping techniques to appear more smooth. Similarly, it will permit more objects to be present in the scene, since the computational power can be  
25 allocated to more objects, at the expense of object quality.

[0008]

An object of this invention is to permit video decoders which lack the

computational power to decode a bitstream to conformance, to decode a bitstream with varying degrees of visual quality degradation. This will permit a wide variety of decoders to be made, each with varying cost/performance trade-offs. An expensive decoder with a very high  
5 computational power can be used to decode bitstreams with a much better resulting quality than an inexpensive decoder with low computational power. By using this invention, the same bitstream may be decoded by a wide range of computational power decoders, to result in varying degrees of acceptable visual quality.

10 [0009]

An object of this invention is to reduce the cost of video decoders. By designing video decoders that are able to meet constraints such as those imposed by MPEG2 MP@ML limitations, excessive computational power overhead must be built into the decoder to guarantee real time picture  
15 decoding of worst-case (high complexity) bitstreams. In other words, the pictures are decoded on time even when the worst case bitstream is decoded.

However, by using this invention, decoders can be made which gracefully degrade picture quality when their performance limitations are met.

[0010]

20 [Means for solving the problem]

For the purpose of solving the above described problems, the method of reducing processing power requirements of a video decoder described herein was invented. Said processing power requirements may be controlled based on a throttling amount. Said throttling amount may be  
25 based on one or more measures of the processing power required to decode one or more bitstreams, one or more measures of said decoder's processing capabilities, or some combination of these measures.

[0011]

The measures of the processing power required to decode a bitstream may comprise of an indication of the syntax elements in said bitstream, an indication of the type of processing required for said bitstream, an indication of the amount of processing required for said bitstream, or some combination of these indications. Reduction of processing power requirements is accomplished by reducing the processing power used for one or more decoder functions by limiting said decoder function in some way. Said limiting may comprise turning off the use of one or more of the motion vectors normally used to retrieve a motion compensated reference. This may be done by selecting from a choice of motion vectors which normally are used to retrieve a pixel regions motion compensated reference predictor region, one or more motion vectors whose use is turned off. Selection of said motion vectors may comprise of selecting the motion vectors which are of temporally longest distance, selecting the motion vectors which are least highly correlated with those motion vectors in surrounding regions of the picture region being decoded, selecting the motion vectors which are of spatially longest distance, selecting all motion vectors, or any combination of these and other selection criteria.

[0012]

Another method for limiting said decoder function comprises of modifying motion vectors, possibly by limiting the precision and/or range of one or more of the decoder's motion vectors. Another method for limiting said decoder function comprises of reducing the number of coefficients inverse quantized and inverse DCT transformed by selectively setting coefficients to alternate values, such as zero. Another method for limiting said decoder function comprises of reducing the amount of decoder

processing used for decoding the color components of the video bitstream.

Another method for limiting said decoder function comprises of reducing the amount of processing performed on the decoder's output video pictures.

[0013]

5           Said throttling amount serves to control which and by how much to limit said decoder functions in some way. It is possible to determine the processing power requirements from one or more bitstreams, as well as the existing processing power capabilities of the decoder, and use this information to make a decision about which and how much to throttle, or limit  
10       said decoder functions during the decoding of said bitstreams. By limiting the decoder functionality, the processing power can be reduced. The identification of which functions to limit and in what way can be made using indications such as the syntax elements in said bitstream, and the type and amount of processing required for said bitstream.

15       [00014]

          Said limiting may comprise turning off the use of one or more of the motion vectors normally used to retrieve a motion compensated reference, based on a decision made with reference to indications in the bitstream about what motion vectors exist, or some other indications from the bitstream or  
20       decoder. The choice of what motion vectors in a picture to turn off can be further refined by selecting the motion vectors which are of temporally longest distance, selecting the motion vectors which are least highly correlated with those motion vectors in surrounding regions of the picture region being decoded, selecting the motion vectors which are of spatially  
25       longest distance, selecting all motion vectors, or any combination of these and other selection criteria.

[0015]

Similarly, said limiting may comprise of limiting the precision and/or range or some other modification of one or more of the decoder's motion vectors. Another method for limiting said decoder function comprises of reducing the number of coefficients inverse quantized and inverse DCT transformed by selectively setting coefficients to alternate values which are easy to inverse quantize and inverse DCT, such as zero. The decision to limit these decoder functions may be based on information regarding said bitstream and/or said decoder. Another method for limiting said decoder function comprises of eliminating some or all of the processing required during color component decoding. Another method for limiting said decoder function comprises of limiting the processing applied to the decoded video pictures.

[0016]

#### [Embodiments of the Invention]

An example embodiment of this invention is shown in Figure 1. One or more bitstreams are input via the bitstream input (100; 101). The video decoder (110) decodes the bitstream and outputs decoded video (120, 121). Measures of the bitstreams' processing requirements (130) and decoder's processing capabilities (131) are passed from the video decoder (110) to the decoder throttler (140). Throttling amount (132) is passed from the decoder throttler (140) to the video decoder (110).

[0017]

The operation of the embodiment in Figure 1 is now described. The video decoder (110) extracts measures of the bitstream processing requirements from the input bitstreams (101) and passes these measures (130) to the decoder throttler (140). The video decoder (110) also determines its capabilities for decoding the bitstream and passes this

measure (131) to the decoder throttler (140). The decoder throttler (140) uses these measures (130, 131) to decide how the video decoder (110) function can be throttled and passes this throttling amount (132) information to the video decoder (110).

5 [0018]

It is possible that no measures of the bitstreams (130) are taken and passed to the decoder throttler (140). In this case, the decoder throttler (140) determines how to throttle the video decoder (110) by using the measure of the decoder's processing capabilities (131), or some other  
10 measure.

[0019]

It is also possible that no measures of the decoder's processing capabilities (131) are taken and passed to the decoder throttler (140). In this case, the decoder throttler (140) determines how to throttle the video  
15 decoder (110) by using the measures of the bitstream processing requirements (130), or some other measure.

[0020]

It is possible that no measures of the bitstreams (130) or decoder's processing capabilities are taken and passed to the decoder throttler (140).

20 In this case, the decoder throttler (140) determines how to throttle the video decoder (110) by using some other measure, or by using some predetermined method. For example, it is possible that due to some information known about the decoder(110) and decoder throttler (140) when their architectures are designed, the decoder throttler (140) can always  
25 throttle in the same way. The number of measures and origin of the measures is not limited by this invention.

[0021]



The effect of the embodiment described by Figure 1 is the ability of the video decoder to throttle it's performance requirements.

[0022]

Another example embodiment of this invention is shown in Figure 2.

5 One or more bitstreams are input via the bitstream input (200, 201). The video decoder (210) decodes the bitstream and outputs decoded video (220, 221). The input bitstreams (202) are passed to the bitstream indicator extractor (250) where measurements are made concerning the bitstream. Indications such as syntax elements (251), type of processing required for  
10 decoding (252), and the amount of processing required (253), are passed to the decoder throttler (240). The decoder's processing capabilities (231) are passed from the video decoder (210) to the decoder throttler (240).

Throttling amount (232) is passed from the decoder throttler (240) to the video decoder (210).

15 [0023]

The operation of the embodiment in Figure 2 is now described. The bitstream indicator extractor (250) extracts measures of the bitstream processing requirements from the input bitstreams (202). It determines indicators which characterise the stream's contents and types and amounts  
20 of processing required to decode the bitstreams and passes these indicators (251, 252, 253 respectively) to the decoder throttler (240). The video decoder (210) also determines it's capabilities for decoding the bitstream and passes this measure (231) to the decoder throttler (240). The decoder throttler (240) uses these indicators (230, 231) to decide how the video  
25 decoder (210) function can be throttled and passes this throttling amount (232) information to the video decoder (210).

[0024]

It is possible that some or all of the indications (251, 252, 253) taken by the bitstream indicator extractor (250) are not used by the decoder throttler (240). In this case, the decoder throttler (240) determines how to throttle the video decoder (210) by using the measure of the decoder's processing capabilities (231), or some other measure.

[0025]

It is also possible that no measures of the decoder's processing capabilities (231) are taken and passed to the decoder throttler (240). In this case, the decoder throttler (240) determines how to throttle the video decoder (210) by using the indications (251, 252, 253) determined by the bitstream indicator extractor (250), or some other measure.

[0026]

It is possible that no bitstream indications (251, 252, 253) or decoder's processing capabilities (231) are taken and passed to the decoder throttler (240). In this case, the decoder throttler (240) determines how to throttle the video decoder (210) by using some other information, or by using some predetermined method. For example, it is possible that due to some information known about the decoder (210) and decoder throttler (240) when their architectures are designed, the decoder throttler (240) can always throttle in the same way. The number of indicators and measures and the origin of the indicators and measures is not limited by this invention.

[0027]

Figure 2 and Figure 3 can be used to describe another embodiment of this invention. In this embodiment, an MPEG2 video decoder is used. The following are extracted by the bitstream indicator extractor (250):

[0028]

□ picture\_coding\_type (I, P, B,D)

□ temporal\_reference

Figure 3 describes a flow chart used to determine which motion vectors (forward or backward) in a B-picture are to be discarded. The temporal\_reference information is used to determine whether the forward or backward reference is of further temporal distance from the picture being decoded. The reference of furthest distance is not used, effectively turning off motion vectors referring to it. In other words, the B-picture only uses uni-directional prediction in this embodiment.

[0029]

The picture\_coding\_type and temporal\_reference are not the only bitstream characteristics which can be extracted and used for throttling the video decoder (210). This invention does not limit the type or number of indicators used for determining the way to throttle the video decoder (210). The invention does not limit the characteristics to specific syntax elements. For example, the characteristics could be indicators that are not specific syntactic elements, like indicators of the number of macroblocks of a particular type. The indicators may have been inserted into the bitstream by the encoder, or may be implied by some bitstream elements. The indicators may be at a higher syntactic level, for example, the system bitstream level.

The indicators taken from the bitstream for a particular element may not be used to control the decoding of that particular element. For example, the indicators associated with one picture may be used to control the decoding of another picture. For example, the indicators of a preceding picture could be used to control the decoding of the current picture.

[0030]

The invention is also not limited to the frequency of video decoder (210) throttling as described by the embodiment described in Figure 3. For

example, the decision of whether to use bi-directional prediction may be made on a pixel region by region case. For example, the decision could be re-evaluated every macroblock.

[0031]

5           Also, the previous embodiment did not describe the use of measures of the decoder processing capability (231). These can be used to detect when a decoder is very busy, at which time it cannot achieve real time decoding of the bitstreams, and so decoder throttling is needed. Likewise, the measures of decoder processing capability (231) can indicate when the  
10          decoder is not busy, and can achieve real time, video decoding with no throttling of it's functions. In other words, the method of making the decision of whether or not to turn off some motion vectors and their associated reference compensation processing, is not limited by this invention.

[0032]

15          The effect of this embodiment is the significant reduction of frame memory accessing and processing for B-pictures. Reference frame memory reading is effectively cut in half due to the absence of the bi-directional processing of motion compensated references. Although the quality of the resulting decoded video is degraded, this is considered an  
20          acceptable side-effect of the invention, since the invention is used to reduce decoder cost by degrading the picture quality. Since B-pictures are not used for further predictions, the errors in the pictures introduced by the throttling do not propagate to other pictures.

[0033]

25          Figure 4 shows an example embodiment in which the picture size and rate is used as an indication of the amount of processing (253) which is required by a bitstream. In this embodiment, the following additional

elements are determined from a bitstream:

[0034]

- ☐ horizontal\_size
- ☐ vertical\_size
- 5 ☐ frame\_rate\_value

These are then used to decide if the decoder will employ some throttling techniques or not, based on the bitstreams required decoder output pixel rate. In the example shown, it is used, but is not limited to, enable the motion vector throttling described by Figure 3.

10 [0035]

In Fig. 3,  $|TR - TR_{for}|$  is the absolute value of the difference in time of the picture being decoded and the picture used as the motion compensated forward reference, and  $|TR - TR_{back}|$  is the absolute value of the difference in time of the picture being decoded and the picture used as the motion compensated backward reference.

15

[0036]

Another embodiment of the invented method modifies the motion vectors in a way that reduces the computational and/or memory bandwidth requirements of the decoder.

20 [0037]

One embodiment utilises the precision of motion vectors. Figure 5 describes how  $\frac{1}{2}$  pixel motion compensated references are determined by using the neighbouring full pixel values. If a spatial region required  $\frac{1}{2}$  pixel interpolations, more reference frame memory pixel data is needed. For example, if an 8x8 pixel region is desired using full pixel motion vectors, an 8x8 region would be required to be read. On the other hand, if both horizontal and vertical  $\frac{1}{2}$  pixel motion compensation was required, a 9x9

25

region must be read. After  $\frac{1}{2}$  pixel interpolations of nearest neighbour full pixel values, the desired 8x8 region would be determined. Thus, it is possible to reduce a video decoder's processing requirements by limiting the precision of it's motion vectors to full pixel precision.

5 [0038]

This invention does not limit the reducing of the precision of the motion vectors from  $\frac{1}{2}$  pixel to full pixel values. In fact, many video decoders do not access the reference frame memories pixel by pixel, but instead group the pixels into accessible words. Thus, limiting motion vector precision to the word size of the reference frame memories can be performed.

10

[0039]

The effect of this embodiment is the reduction of frame memory accessing and processing for pictures using motion compensated prediction.

Although the quality of the resulting decoded video is degraded, this is considered an acceptable side-effect of the invention, since the invention is used to reduce decoder cost by degrading the picture quality.

15

[0040]

Another embodiment of the invented method reduces the motion vector range. For example, if the range of motion vectors is +/- 64 pixels, the range can be limited to +/- 16 in the decoder. The limited range is not specific to this embodiment. For example, it could be limited to 0 pixels.

20

[0041]

The effect of this embodiment is that the frame memory accessing is restricted to a smaller region of the picture. This can be particularly useful in motion compensation architectures which use memory cache. The more pixels which are accessed from cache, the fewer cache hits. Cache hits mean that the desired pixel is not in the cache memory, so they must be

25

fetches from a typically bigger and slower memory which holds the desired pixels. The overall effect of a cache hit is a reduced processing performance. The effect of reducing the motion vector range is to reduce the number of cache hits, and thus improve processing performance.

5 [0042]

Another embodiment of the invented method modifies the values of some of the coefficients decoded from the bitstream in order to make the downstream processing of these coefficients less computationally intensive.

10 An example of such a modification is shown in Figure 6. The original coefficients from the bitstream (600) are modified to result in the modified values (601). In this example, all values outside of the grey area (602) are set to zero. The effect of this in a DCT based system such as MPEG2 for example, where a video decoder typically performs inverse quantization before inverse DCT, is that by setting the coefficient values decoded from the  
15 bitstream to values easily inverse quantized, the processing requirements for inverse quantization can be reduced. For example, if some of the coefficients are set to zero, the result after inverse quantization of these coefficients can be set to zero without the usual calculations as defined by the MPEG2 standard. In addition, some implementations of an inverse DCT  
20 utilize detected coefficients that are zero to reduce the computational requirements of the inverse DCT. For example, in a separable inverse DCT in which a subset of the coefficients are to be transformed, if the subset is all zero, the results will also be all zero. In this case the inverse transform can be completed much easier simply by setting the results to zero rather than by  
25 calculating the inverse transform.

[0043]

This invention is not limited to setting coefficient values from the

bitstream to zero. They can be modified to any value which results in less downstream processing. It is also does not limit which values are modified.

For example, it is possible to limit the number of non-zero coefficients in a block simply by stopping the saving of the values from the bitstream once the limit for the block is reached. This invention is not limited to decoders using the inverse DCT as it's transform. Other transform's coefficients can also be modified to reduce their computational requirements. Another embodiment of this invention is the reduction or elimination of the processing of one or both of the color components. For example, the coefficient values can be discarded and the pixel values for the color components set to neutral.

In this case, there is no further processing of the color components required by the decoder. For example, inverse quantization, inverse DCT and motion compensation are not required for the color components. The effect of this embodiment is the significant reduction of decoder processing requirements. Another effect is the loss of color in the displayed picture, but this may be an acceptable degradation due to the reduced decoder computations.

[0044]

Another embodiment of this invention is the reduction of processing performed on the decoded video pictures. For example, post filters can be used by a video decoder to remove some blocky noise introduced by the encoding and decoding processes. The effect of reducing this filtering is the reduction of the computational requirements of the post filter. The reduction of the processing can be the reduction of the number of taps used by the post filter. Other forms of post processing can also be reduced, such as format conversion filters.

[0045]



There are many combinations of the invented methods which can be used to reduce the processing power requirements of a video decoder. This invention does not limit the combinations. For example, motion vectors can be modified, the coefficients extracted from the bitstream can be modified, and the processing performed on the decoded pictures limited within the same decoder.

[0046]

The overall effect of this invention is the great freedom of control over the processing requirements and output picture quality of a video decoder.

This control is useful when decoding single bitstreams or multiple bitstreams that may have associated priorities.

[0047]

[Effect of the invention]

One effect of this invention is that the processing power of video decoders can be reduced, permitting bitstreams with high computational requirements to be decoded by decoders with lower computational ability. By basing the decision of the type and amount of decoder function limiting on measures of the processing power required to decode bitstreams, measures of said decoder's processing capabilities, or some combination of these measures, an appropriate choice of limiting can be made which balances the trade-off between computational requirements and picture quality. An effect of using indications of the syntax elements in a bitstream and types and amounts of processing in said bitstream is that the type and amount of decoder function limiting can be made considering the content of the bitstream, thus permitting a more suitable and visually appealing choice for function limiting.

[0048]

An effect of using measures of the decoder's processing capabilities is that it permits the selection of functions to limit to be based on the decoder's abilities, which is dependant on the decoder's architecture. An effect of reducing the computational power of one or more functions in a decoder is the reduction of the decoder's computational power. An effect of turning off the use of one or more of the motion vectors normally used to retrieve a motion compensated reference is a reduction in processing requirements and reference frame memory access bandwidth.

[0049]

An effect of selectively turning off the use of one or more motion vectors is that it is possible to select those motion vectors to turn off which have a less detrimental affect on picture quality than others, thus permitting a trade-off between picture quality and computational requirements. An effect of limiting some of the motion vectors which are of temporally longest distance is that the visual quality is typically less affected by turning off some of these than it is for motion vectors of shorter temporal distance. An effect of limiting the motion vectors which are least highly correlated with those motion vectors in surrounding regions of the picture region being decoded is that the perceptibility of degrading the picture quality of the regions with these motion vectors may be less than that of degrading more highly correlated motion regions.

[0050]

It also has the effect of permitting cache based architectures for motion compensation functions to have fewer cache hits if the less highly correlated motion vectors are not used. An effect of selecting the motion vectors which are of spatially longest distance is that it may permit cache based architectures to have fewer cache hits if the motion references are

more close together, since presumably the reference data would not be going outside of the cache so often. An effect of modifying the motion vectors or limiting the precision and/or range of one or more of the decoder's motion vectors is that the number of memory accesses can be reduced when  
 5 accessing motion compensated references.

[0051]

An effect of reducing the number of coefficients inverse quantized and inverse DCT transformed by selectively setting coefficients to alternate values, such as zero, is that the computational requirements of inverse  
 10 quantization and inverse DCT can be reduced. An effect of reducing the processing of the color components is the overall reduction of decoder processing.

[Brief description of drawings]

Figure 1 : Block diagram of first embodiment of the invention

15 Figure 2: Block diagram of second embodiment of the invention

Figure 3 : A flow chart of the embodiment using motion vector throttling

Figure 4 : A flow chart of the embodiment using picture size and rate

Figure 5 : A diagram showing  $\frac{1}{2}$  pixel motion compensation

Figure 6 : A diagram showing modifying coefficient values

20 [Description of symbols]

100, 101, ...bitstream input

110 ...video decoder

120, 121 ...decoded video

140 ...decoder limiter (throttler)

25 200, 201 ...bitstream

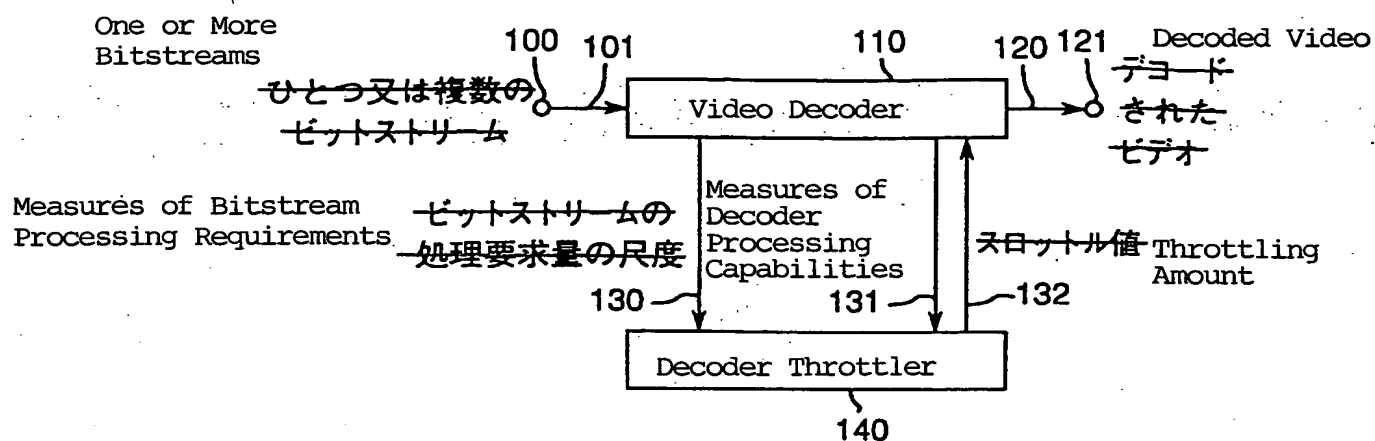
210 ...video decoder

240 ...decoder limiter (throttler)

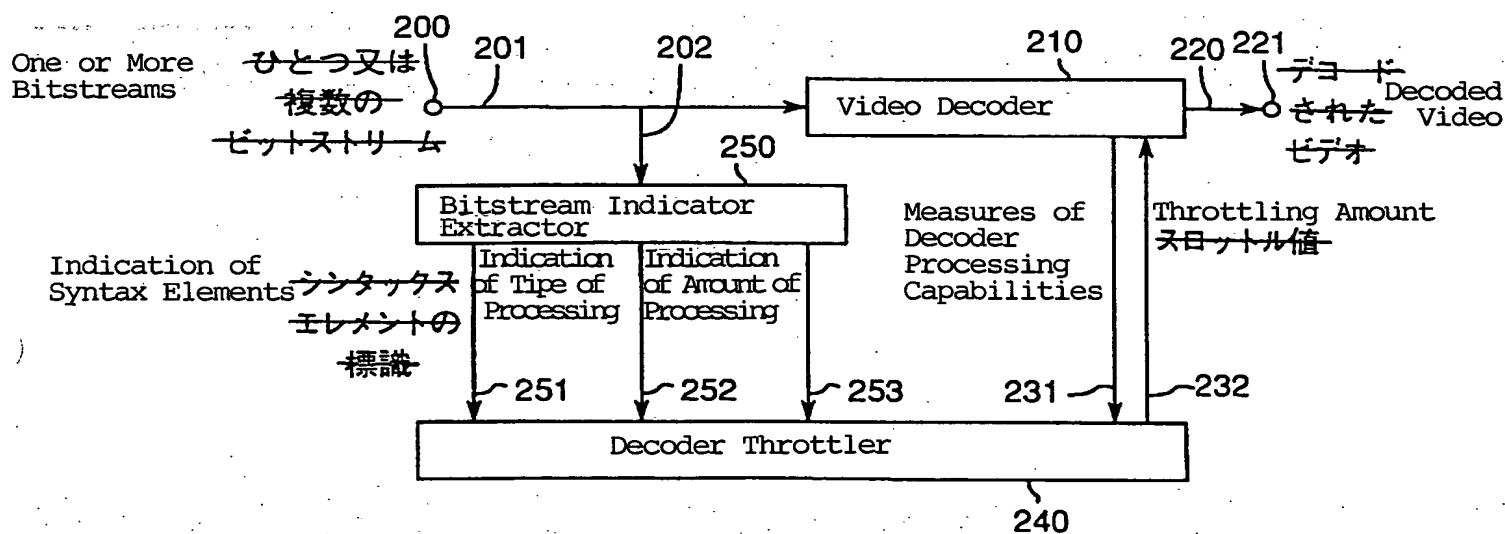
250 ---bitstream indicator extractor

【書類名】 図面 Document Name: Drawings

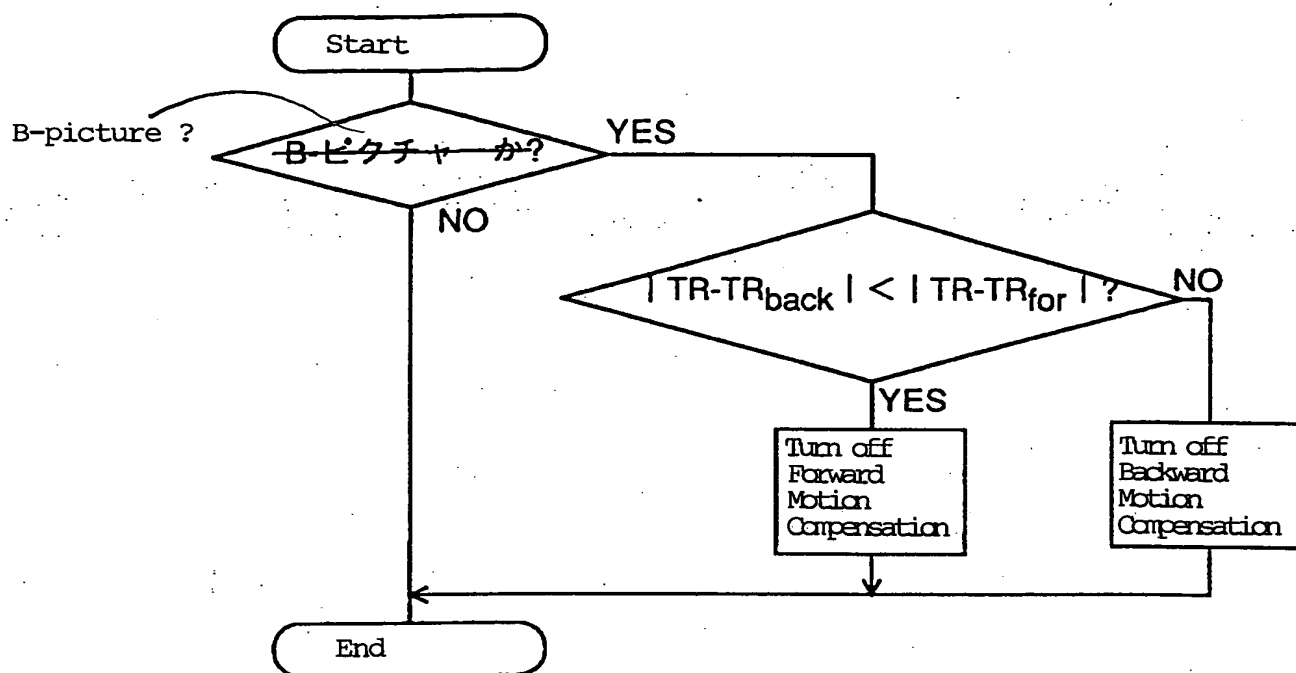
【図1】 Fig. 1



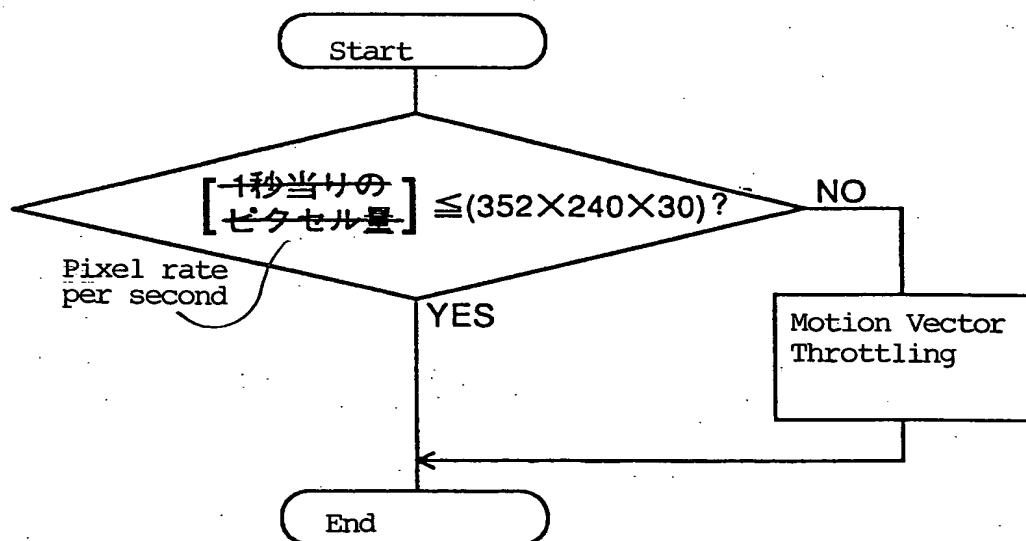
【図2】 Fig. 2



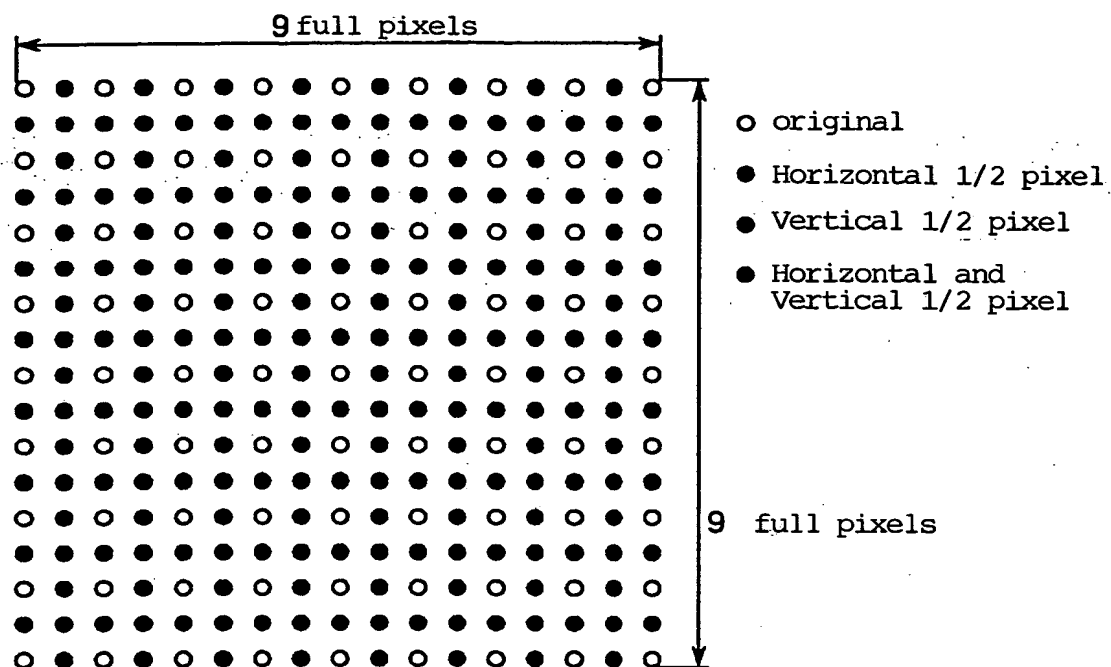
【図3】 Fig. 3



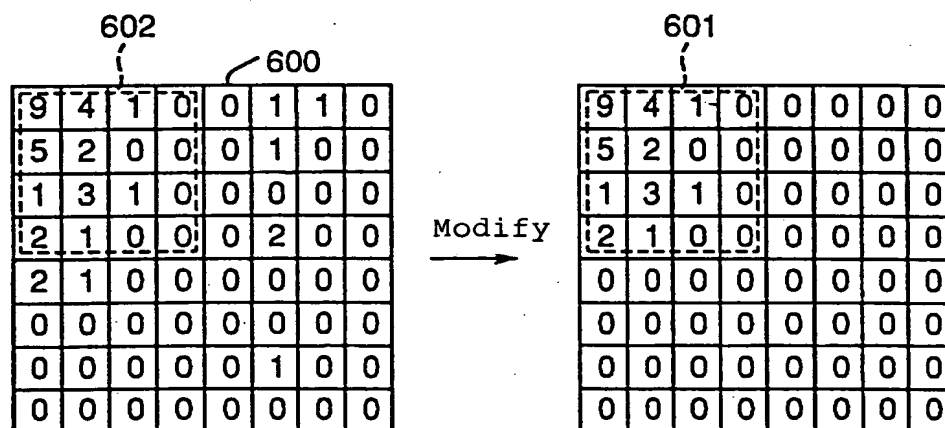
【図4】 Fig. 4



{图5} Fig. 5



{图6} Fig. 6



[Document name] Abstract

[Abstract]

[Problem]

5 The object is to present video decoders of varying degrees of computational power to decode bitstreams with varying degrees of visual quality degradation.

[Means for solving problem]

10 To match with the video decoder's maximum processing power, the processing power requirements of a video decoder based on both bitstream contents and decoder capabilities are reduced. One method it uses is the reduction of motion compensation processing by modifying the use or values of motion vectors, such as by turning some motion compensation off, or by limiting the precision of motion vectors during decoding. Another method is by limiting the coefficient processing so as to reduce the computational requirements. Another method is to limit the processing of color  
15 components, and another method is by reducing the amount of filtering performed on the decoder's output video pictures.

[Selected figure] Fig. 1



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Applicant:

Identification No.: 000005821

Address: 1006, Oaza Kadoma, Kadoma-shi, Osaka, Japan

Name: Matsushita Electric Industrial Co., Ltd.

Patent Attorney:

Identification No.: 100062144

Address: Aoyama Tokkyo Jimusho

c/o IMP Building, 3-7, Shiromi 1-chome, Chuo-ku, Osaka, Japan

Name: Tamotsu AOYAMA

Appointed Patent Attorney:

Identification No.: 100086405

Address: Aoyama Tokkyo Jimusho

c/o IMP Building, 3-7, Shiromi 1-chome, Chuo-ku, Osaka, Japan

Name: Osamu KAWAMIYA

Applicant Record

Identification No.:     【000005821】

1.   Date of Registration: August 28, 1990   (newly recorded)

Address: 1006, Oaza Kadoma, Kadoma-shi, Osaka, Japan

Name:     Matsushita Electric Industrial Co., Ltd.